THE

Nernst Lamp

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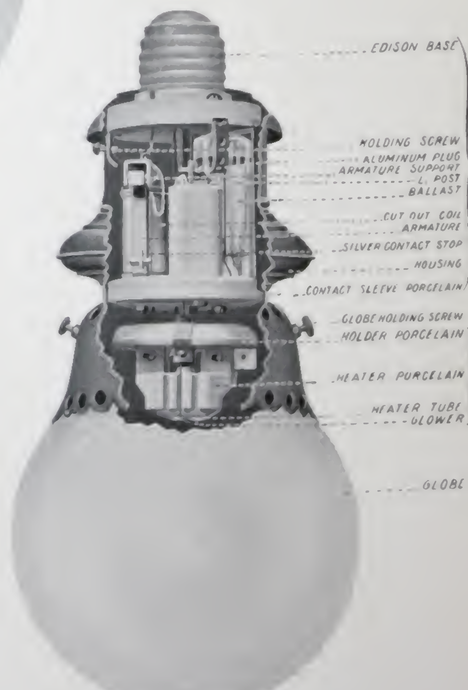
NERNST LAMP COMPANY
PITTSBURGH PA

Two-Glower Lamp.



One-Glower Lamp.

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ARTIFICIAL ILLUMINATION is one of the necessary luxuries of life, and methods of producing it are older than history, but it is only the past few decades that have witnessed extraordinary activity in improved sources of supply. It is also interesting to note that of all the illuminants which have ever been used, none has been discarded.

Through the agency of arc and incandescent lamps, electricity plays an important part in our manner of living, and electric lighting is recognized as being far superior to any other in point of health and convenience. Nevertheless it is a well recognized fact that our present methods of illumination are still very inadequate, particularly in point of efficiency, and scientists and engineers are continually striving for improvement in various directions.

Great Possibilities

As evidence of this activity, note the economy effected in gas lighting by the Welsbach mantle, now in such general use. It has remained, however, for a German scientist, Dr. Nernst, of Goettingen, to accomplish for electricity what Welsbach did for gas. It was early in 1898 that Dr. Nernst exhibited in this country his new type of incandescent electric lamp. Mr. Westinghouse immediately recognized in it great possibilities for improving the then existing methods of illumination, and placed at work upon it a staff of engineers, who have developed it into the present commercial form.

The Glower

The nucleus, or light-emitting element of the lamp, is termed a "glower." It is made by pressing through a die, a dough composed of the oxides of the rare earths mixed with a suitable binding material. The porcelain-like string thus formed is cut, after drying, into convenient lengths.

[illegible]

It is then baked, and terminals are attached, by means of which a current of electricity may be passed through the glower.

The terminal connection between the glower and lead wire, as Dr. Nernst usually made it, consists of a few turns of platinum wire wound around each end of the glower, the convolutions being finally pasted with cement. Another successful terminal is one in which beads of platinum are embedded in the glower ends and to which lead wires are subsequently attached; with this, any shrinkage of the glower material results in a firmer contact with the platinum.

Advantages The glower of a standard 220-volt Nernst lamp is about 1″ long by $\frac{1}{32}$″ in diameter. This glower possesses many interesting features and advantages. It is an oxide incapable of further oxidation, therefore operative in the open air, and being capable of constantly withstanding a much higher temperature than is the filament of the ordinary incandescent lamp, it admits of great economy of operation and provides a superior color and quality of light. Glowers are insulators when cold, but become conductors when hot, hence they must be heated before they will conduct electricity sufficiently well to maintain themselves at a light-emitting temperature.

An Electrolyte From the many phenomena observed in studying the operation of glowers under various conditions, it seems altogether probable that the glower is a solid electrolyte, and furthermore, oxygen apparently is useful in its operation. The electrolytic phenomena appear to be more marked with direct than with alternating current, and it is thus found desirable in practice to provide a different form of glower for each system.

The Ballast The characteristic of the glower with reference to voltage and current is remarkable, and has given rise to a steadying resistance called the "ballast." As the current traversing the glower is increased, the voltage across its terminals rises, at first rapidly, and then more and more slowly to a maximum; it then drops off with increasing rapidity as the


current through the glower and the resulting temperature continue to increase. Beyond the point of maximum voltage, the rapid decrease in the resistance of the glower makes the current difficult of control. Without a steadying resistance, such a conductor would rapidly develop a short circuit and "flash out." In the Nernst lamp this steadying or ballasting is accomplished by means of a fine iron wire mounted in a small glass tube, somewhat resembling a miniature incandescent lamp. The diameter of this wire in a .4 ampere ballast is about .045 mm., or less than .002" —smaller than a hair.

Characteristics of the Ballast

Iron wire possesses the property of increasing its resistance with great rapidity on reaching its so-called critical temperature. This increase of resistance with temperature is true to a certain extent of all metals, but iron possesses it to a remarkable degree when at a dull red heat.

This change of electrical resistance at the critical temperature is only one of several noteworthy features. Other characteristics are loss of magnetic properties and change in co-efficient of expansion, as well as marked thermal peculiarities known as "recalescence."

To prevent the rusting or oxidation of this fine iron wire which at the operating temperature would occur immediately in the open air, the enclosing bulb is first exhausted of air and then provided with an inert atmosphere. This gas has no injurious action upon the iron, while its great heat conducting capacity permits of the use of a smaller wire, and therefore of a much smaller ballast, than would be possible with other gases.

The decided negative resistance temperature co-efficient of a glower may thus be more than counter balanced by the more pronounced temperature co-efficient of the iron wire ballast placed in series with it. This exceptional characteristic of the ballast is shown in Fig. 1, from which it will be noted that for a 10% rise in current the resistance in the ballast increases 150% so that a glower thus protected at once becomes operative through a wide range of voltage.

Other Resistances

A glower could be controlled by a sufficiently large steadying resistance possessing no especial temperature correction, but such a resistance would reduce very materially the net efficiency of the lamp; the resistance required under high voltages would be ever present under the normal conditions, in distinction from the ballast which has a comparatively low resistance in similar cases, but automatically increases its resistance for abnormal rises in voltage. It is also important to have the

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corrective property of the ballast immediately available to check even a momentary rush of current through the glower at starting, or, in fact, at any time. This requires that the ballast shall

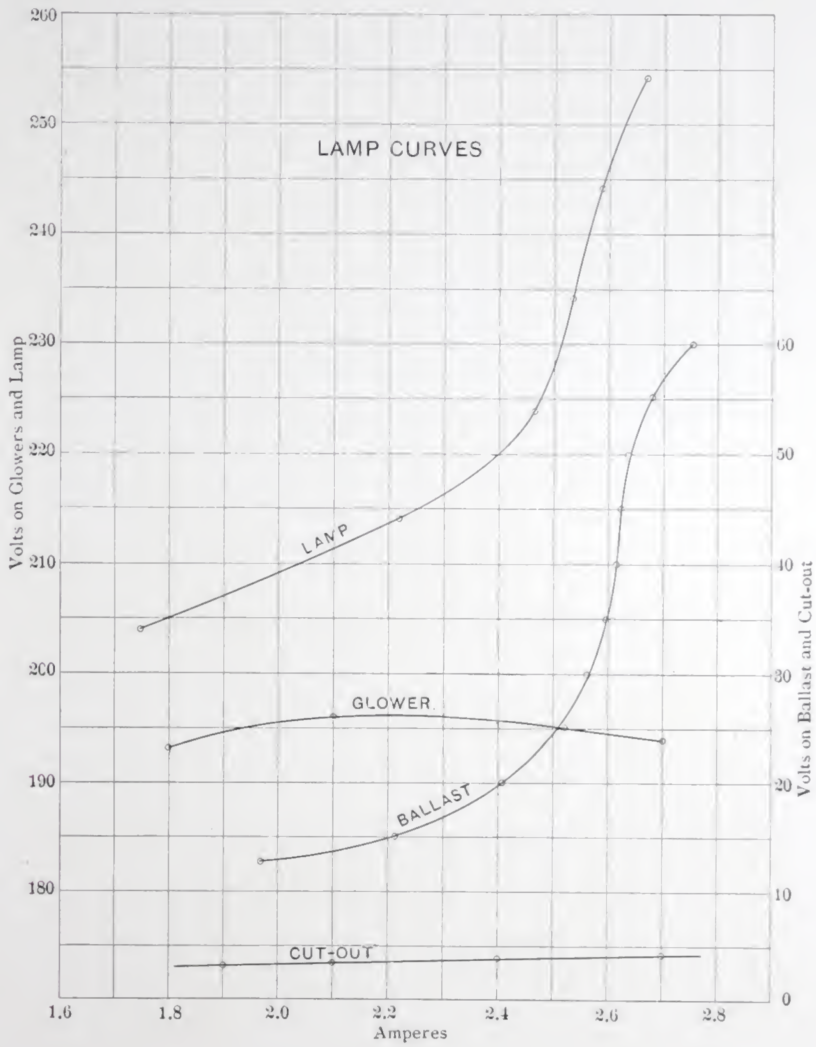

Fig. 1

possess small heat capacity. To attain this important feature, the iron wire is mounted freely in the gas contained in the glass envelope and is thereby capable of instantly assuming the new temperature imposed upon it by a change in line voltage.

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Heater Tubes The construction of a commercial and entirely automatic lamp requires, in addition to the glower and ballast, a device to provide for the initial heating of the glower. Though numerous methods of effecting this heating have been suggested and tried, it is natural that electrical means should prove to be the more practical.

The glower becomes a good conductor at about 600 or 700 degrees Centigrade. To acquire such a temperature quickly and without rapid destruction of the heater and adjacent parts, renders the selection of materials for the purpose a serious problem. Platinum for the heater may seem costly for the commercial lamp, but, although many attempts have been made to devise a cheap mineral heater, platinum still holds its own as the least expensive, the most durable, and altogether the most desirable for the pur-

pose. The actual expense is not at all serious, because a large per cent. of the platinum thus used may be recovered.

The heaters consist of thin porcelain supports overwound with fine platinum wire which in turn is held in place and protected from the intense heat of the glowers by a refractory paste.

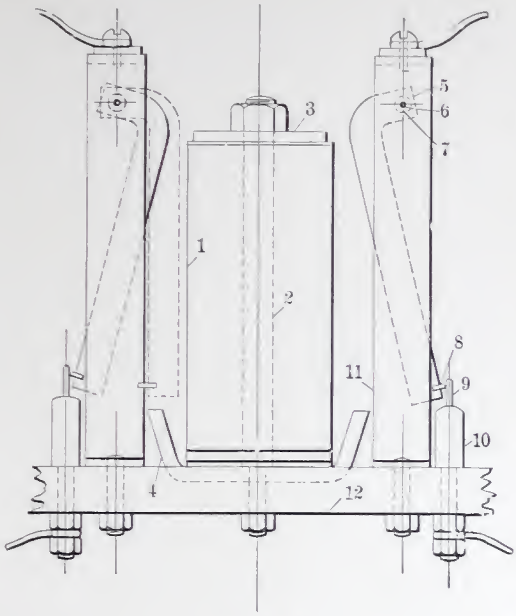

FIG. 2

Cut-Outs The automatic lamp is constructed with a cut-out to disconnect the heater from the circuit as soon as the glowers light. The cut-out comprises a coil, an armature and a contact. The coil is heat proof, being embedded in cement. The contact is non-oxidizable, being of silver.

One form of cut-out is shown in Fig. 2, in which 1 is the coil, 2 the iron core, 3 an iron washer on top of the coil to help complete the magnetic circuit, 4 an iron yoke on the lower end of the coil forming the pole pieces of the electro-magnet, 5 is an armature supported from a silver pin 6 and provided with a silver bushing 7. The current passes from the post supporting the armature to the pin 6, the bushing 7, the armature 5, and through the armature to the movable contact 8, thence to the fixed contact 9.

The illustrations on page 2 show the manner of assembling the elements of the Nernst lamp. From Fig. 6, page 19, it will be noted that there are two circuits; one including the heater and the contact of the automatic cut-out, while the other is through the glower, the ballast and the cut-out coil.

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Garrison Place and Fayette Street, Pittsburgh, Pa.

Lamp Characteristics

The voltage current characteristics of the assembled lamp and its elements are shown in Fig. 1, the marginal values being those of the six-glower lamps. The voltage candle power characteristics of Nernst and incandescent lamps are shown in Fig. 3. This curve shows the relative change in candle power when operating on a circuit of varying voltage, all the variations in this case being given in per cent. of the normal conditions. The voltage efficiency characteristics of Nernst and incandescent lamps under the same conditions are given in Fig. 5.

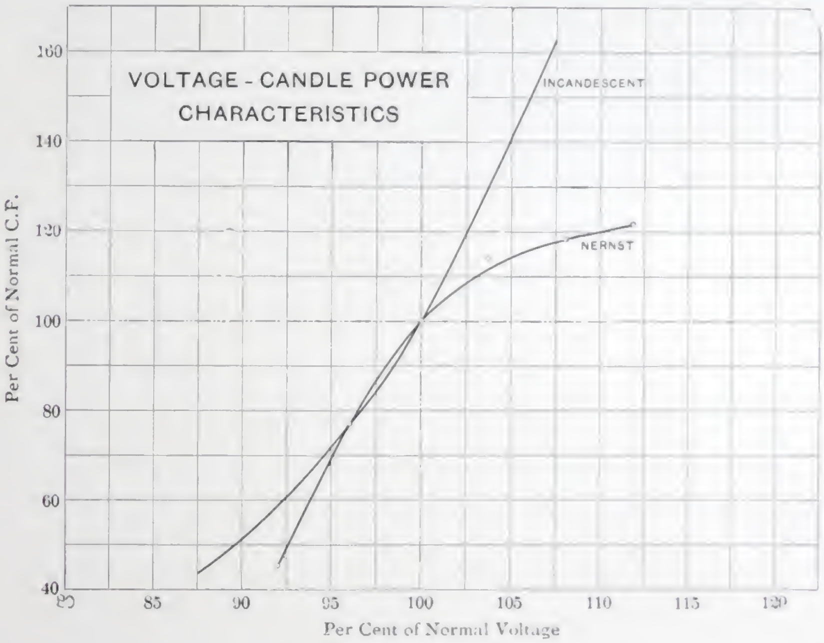

Fig. 3

It will be observed that the efficiency of the Nernst lamp is practically constant when operating at an overvoltage, this being due to the great corrective power of the iron ballast.

The Starting Current

Briefly, the action of a Nernst lamp when the switch is turned on is as follows:

(1) The current passes through the heater bringing it to a white heat; (2) the proximity of the glower to the

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heater results in the glower becoming a conductor, through which the current then passes; when the current through the glower has reached a predetermined amount; (3) the cut-out coil becomes energized by virtue of the glower current passing through it; (4) the armature of the cut-out which had heretofore closed the heater circuit is attracted; and (5) this opens the heater circuit, leaving only the glowers in operation until the next time the lamp is turned on. Ordinarily about thirty seconds is the time required for starting. Opening the switch which controls the lamp circuit allows the cut-out armature to fall into place again, thus connecting the heaters ready for starting.

Fig. 4 expresses graphically what occurs in the lamp from the moment the current is turned on until all the glowers of a multiple glower lamp are lighted. The

values indicated in the margin are typical of the six-glower 500-watt lamp, which ordinarily takes 2.4 amperes. Until about twenty-five seconds have elapsed, the values of current are those taken by the heater. The glowers then start to take current, and at the end of thirty-one seconds the cut-out acts, throwing the heater out of service; the remaining glowers lighting from the first two. The glower current reaches its maximum at the end of about forty seconds and the gradual depression in the curve from this time on is an effect of the lamp body and ballasts while attaining their normal running temperature.

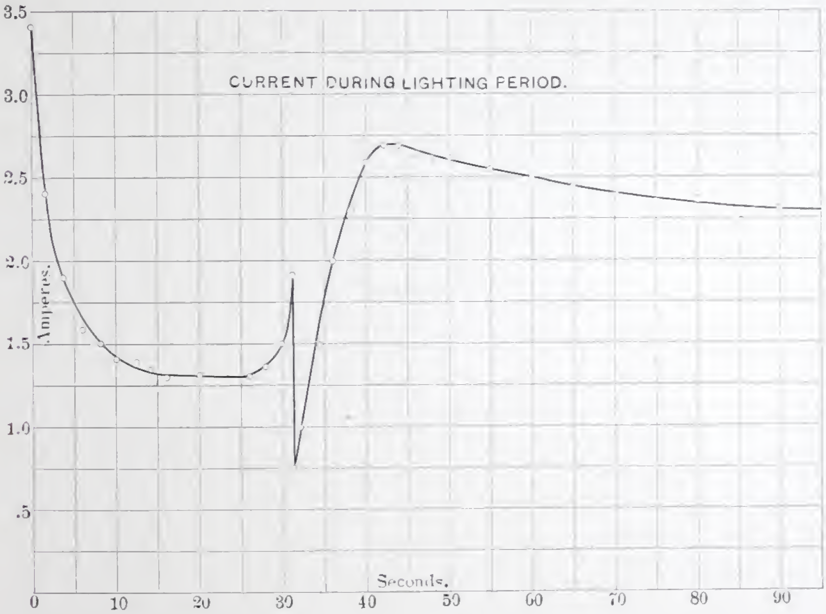

FIG. 4

General Construction

Although the Nernst lamp may be made to operate in any position, the present line of manufacture is directed more particularly toward lamps to be hung in a vertical position, to gain the advantages possessed by a downward distribution of light.

The main features are alike in all the lamps. Various sizes are made by assembling one or more standard glowers with their requisite heaters, ballasts and cut-out.

Street Lighted by Nernst Lamps.

The replacement of perishable parts has been made ideal in its simplicity by the use of aluminum plug contacts for glowers, heaters and ballasts, instead of the corroding contacts and troublesome screws so often used in electrical devices. Prompt renewals in Nernst lamps are still further facilitated by mounting the perishable parts on a removable piece called the "holder,"

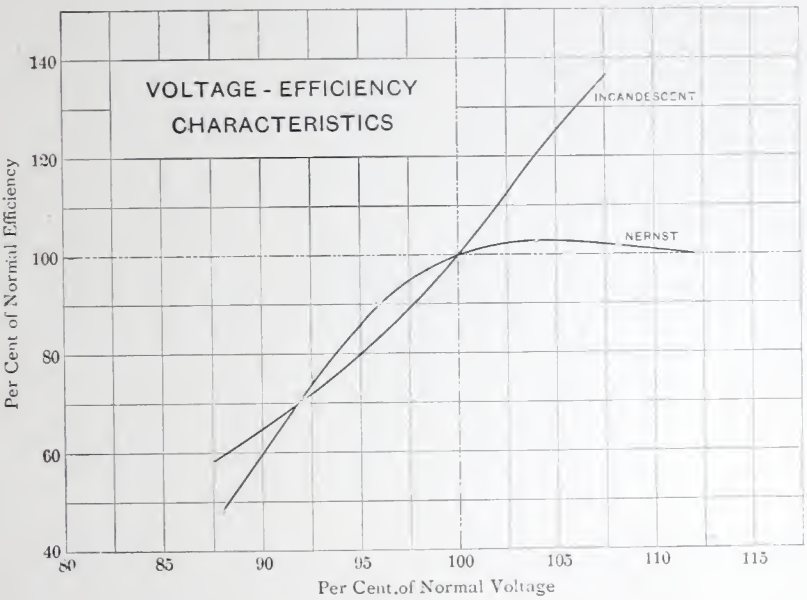

Fig. 5

which may be pushed into place like an incandescent lamp into its socket. In fact, the housing of the lamp which contains the ballast and cut-out may be considered as a special Nernst lamp socket. With a few spare holders on hand, the inspector or user has only to pass from lamp to lamp, changing the holders when necessary and then reloading the old holders at some convenient time and place.

Details of Construction

The six-glower lamp is typical of all the others. This lamp is hung from a suspension eye which, being removed, allows of immediate access to the inner parts. On removing the housing, we find the ballasts arranged in a semi-circle around the cut-out and easy of access.

Pool Room—Casino, East Pittsburg, Pa.

All parts are mounted on porcelain; there being no combustible material in the lamp.

The assemblage of parts and electrical connections of a six-glower lamp are shown diagrammatically in Fig. 6. 1 and 2 are the terminal connections to the line. Following from one, the first path or "heater circuit" is through the heater to the cut-out, and then to the line at 2. The second path or "glower circuit" is through the glower, the ballast, and finally through the cut-out coil back to the line.

The holder is so designed that the heat is stagnated, thereby lighting the glowers in minimum time. This stagnation of heat also contributes to the high efficiency of the glowers.

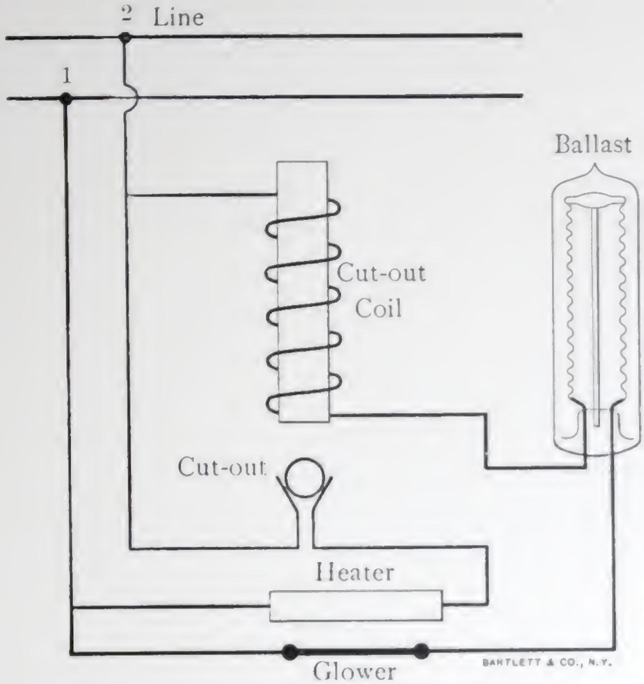

FIG. 6

The six-glower holder is provided with nine contact prongs, which, when the holder is placed in the lamp, automatically make the desired connections between individual glowers and their corresponding ballasts.

The holder of the Nernst lamp is replaced in a manner similar to the removal of an incandescent lamp.

Distribution of Light

The horizontal glower Nernst lamp has been designed to throw the largest amount of light in the direction of greatest use. A totally different distribution of light from any other electric lamp heretofore made is thus obtained.

A most effective illumination may be obtained by placing the units of light well above the line of vision, preferably in the ceiling, so that the light is thrown downward. In this manner a uniform and highly satisfactory illumination is obtained.

It would seem that this superior distribution of light should result in the removal of all lights from the line of vision to the

great relief of the eyes; and the placing of lamps in the ceiling or as ceiling clusters.

Efficiency The question of efficiency of a light source involves so many considerations that a common ground for discussion is always difficult. It should be borne in mind that the impression of light is solely a physiological effect and hence the most efficient form of lamp for a given purpose is one which gives the illuminating effect sought with the least expenditure of energy.

By means of the photometer, useful illumination curves may be deduced which are instructive and of great value not only in research work but also in the practical determination of the location and distribution of illuminants, but the effective illuminating power is best determined by actual observation

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and demonstration. A simple example will illustrate the point. Let us assume two lamps exactly the same in every respect except that one throws all its light upward, whereas the other throws all its light downward. The two lamps as measured on the photometer, or on the basis of mean spherical candle power, would be placed on an exactly equal footing, but as a source of effective illumination, obviously the lamp which throws most of its light in the direction of greatest use is the lamp which has the highest practical efficiency.

A further consideration in the economy of effective illumination is the fact that a light source within the line of vision for example a wall light—diminishes greatly its own usefulness because fewer rays reflecting from the objects to be illuminated can enter the eye owing to the pupil of the eye being contracted, or blinded by the direct rays from the light source.

Steady Light

In addition to its high efficiency and the beautiful quality of its light, the Nernst lamp has another advantage, namely, steadiness. It is but slightly effected in candle power by variations in the line voltage and is entirely free from noticeable pulsations of the light even on alternating current of low frequency.

Summary of Advantages

The peculiar advantages of the Nernst lamp may be briefly summarized as follows: High efficiency, beautiful quality of light, not sensitive to pulsations in voltage, ideal distribution of light, absence of shadows from the lamp itself, no vacuum, leaving the glassware removable for cleaning, the lamp itself is a permanent structure in which the renewals may be easily and quickly made.

Field of Nernst Lamp

Without going into statistics, it seems highly probable that there are as many candles burned to-day as there were fifty years ago; the kerosene lamp is in use the world over, gas, with the advent of the Welsbach mantle, is used more than ever. Each new illuminant as it appears, opens up a field of its own, creates new fields and a demand for more and more light.

Bowling Alley—Casino, East Pittsburg, Pa.

It is not expected that the Nernst lamp will supplant other illuminants to any marked degree but that it will create for itself a field of its own. Owing to its brilliancy and economy, it will excite a demand for more light, increasing rather than decreasing the use of other illuminants.

Two Sets of Voltages

Nernst lamps are operative on two sets of voltages, one set ranging from 100 to 120 volts and the other from 200 to 240 volts. There are two distinct types of lamps for service on these two sets of voltages, namely, the 110 volt type of lamp and 220 volt type of lamp. The 110 volt type of lamp is adjustable for any voltage from 100 to 120 and the 220 volt type of lamp is adjustable for any even voltage from 200 to 240 volts. The voltage of either type of lamp is governed exclusively by the

glower; heater tubes and ballasts remain the same in a given lamp of a given type; in other words, a Nernst lamp adjusted for 200 volts is exactly the same in every respect as the same lamp adjusted for 240 volts with the exception of the glower. Further, it is important to observe that glowers intended for one size of Nernst lamp are not interchangeable in other sizes of lamps of the same voltage. For example, a glower suitable for a 220 volt single glower lamp should not be placed in a six-glower lamp though operating on the same circuit.

Useful Notes

(1) The heater of a Nernst lamp will be cut into circuit in a six-glower lamp when four glowers are burned out, in a three glower lamp when two glowers are burned out, in a two glower lamp when two have burned out and in a one-glower lamp when its glower has burned out.

(2) The greater the number of alternations, the longer the life of the glower.

(3) It is not desirable to place a Nernst lamp inside of an outer globe. The Nernst lamp is a finished lamp in itself, and the shell or housing of a Nernst lamp will cast a shadow on the outer globe, producing an inartistic effect.

(4) The power factor of a Nernst lamp is 100% and the watt consumption is equal to the product of the volts times the amperes.

(5) A 220 volt lamp runs at the same efficiency as a 240 volt lamp, but the latter will have a correspondingly higher candle power and watt consumption.

(6) If all the distinguising marks on two Nernst lamp bodies are removed, the size of the ballast wire will quickly determine whether the lamp belongs to the 110 volt or the 220 volt type, the smaller wire indicating the higher voltage.

(7) The voltage of a single heater tube for a 220 volt lamp is 110; the voltage of a single heater tube for a 110 volt circuit is 55.

(8) Glass ware should be attached loosely to the lamp bodies, allowing for expansion and contraction.

(9) Large globes should be protected with a wire net.

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